a3 cont'd

re-transmission time-out can also be implemented, as in the prior art. In the presence of successive re-transmission time-outs, the back off duration is doubled for each re-transmission time-out. The re-transmission time-out can be calculated in the same manner as in TCP Reno, or as described below. --

On pages 13-14, bridging paragraph

--Since, in the system of the present invention, negative acknowledgments are only sent when receiver 17 detects problems, no negative acknowledgment over a long period of time can either indicate a serious problem because the negative acknowledgments are not getting through or can indicate that the network is lightly loaded and has not yet encountered a problem serious enough to warrant a negative acknowledgment. Since transmitter 15 cannot rely on the presence or absence of negative acknowledgments for re-transmission time-out detection, it can periodically generate keep-alive requests on a much finer granularity than a keep-alive timer in the prior art, which is in the range of one second. Receiver 17 can generate an acknowledgment in response to the keep-alive request. For example, as shown in Fig. 8 at steps 110, 112, 114, 116, and 118, transmitter 15 periodically transmits a keep-alive request, typically piggy-backed on an outgoing data packet, and set re-transmission time-out timer 38. If an acknowledgment for the keep-alive request is returned within the re-transmission time-out interval, the re-transmission time-out timer 38 is cleared, and the process repeats at predetermined periods. If no acknowledgment is received at transmitter 15 within the re-transmission time-out interval, a re-transmission time-out occurs, and transmitter 15 backs off for a predetermined period, preferably according to the exponential back-off algorithm. On return from back-off, the process repeats. Generally, no packets are re-transmitted unless negative acknowledgments are received from receiver 17, and packet transmission continues with the next scheduled packet. Packets lost in network 12 will be negatively acknowledged when receiver 17 determines which, if any, packets were lost. --

a4

In the Claims:

a5 B1

1. (Amended) A method of transmitting data in a data communications network, comprising the steps of:

Received from <+6135639869> at 2/18/03 2:17:39 PM [Eastern Standard Time]

(i) establishing a communications link between a transmitter and a receiver through a TCP handshake, the communications link having a congestion window set to an initial length;

(ii) transmitting data packets from the transmitter to the receiver;

(iii) detecting a missing packet at the receiver;

(iv) sending a negative acknowledgment from the receiver to the transmitter for the missing data packet, the receiver being unresponsive to receipt of any other packets from the transmitter;

(v) decreasing, at the transmitter, the length of the congestion window in response to receipt of the negative acknowledgment; and

(vi) re-transmitting the missing packet.

7. (Amended) A method according to claim 1, further comprising periodically sending a keep-alive request from the transmitter to the receiver, whereupon a re-transmission time-out timer is set, the receiver being responsive to the missing data packet and the keep-alive request and being unresponsive to receipt of any other packets from the transmitter.

11. (Amended) A method for error recovery in a data communications network where data is transmitted as a sequence of data packets sent from a transmitter to a receiver, a communication link between the transmitter and the receiver being established through a TCP handshake, comprising the steps of:

detecting a missing packet at the receiver;

sending a negative acknowledgment from the receiver to the transmitter for the missing packet, the receiver being unresponsive to receipt of any other packets from the transmitter;

setting a missing-packet timer at the receiver upon sending the negative acknowledgment; and

where the missing packet is not received at the receiver in response to the negative acknowledgment before expiry of the missing-packet timer, sending a further negative acknowledgment.

12. (Amended) An error recovery method according to claim 11, wherein the step of detecting a

Received from < +6135639869 > at 2/18/03 2:17:39 PM [Eastern Standard Time]

a7 cont'd

missing packet includes the step of detecting a missing packet according to a gap in sequence numbers of the stream of data packets, the step of setting a missing-packet timer settings a missing packet timer when the gap is detected.

15. (Amended) A method for congestion control in a data communications network where data is transmitted as a sequence of data packets from a transmitter to a receiver, a communication link between the transmitter and the receiver being established through a TCP handshake, comprising the steps of

a8 B1

setting a congestion window to an initial size, the congestion window relating to a transmission rate over the network;

transmitting a data packet from the transmitter to the receiver;

setting a round-trip timer at the transmitter upon sending the packet;

sending a negative acknowledgement for a missing packet from the receiver to the transmitter, the receiver being unresponsive to receipt of any other packets from the transmitter.

C1

increasing the congestion window if no negative acknowledgment forthe missing packet is received before expiry of the round-trip timer; and

decreasing the length of the congestion window if the negative acknowledgment for the missing packet is received at the transmitter.

17. (Amended) A congestion control method according to claim 16, further comprising the step of sending a round-trip time update request to the receiver, the receiver being responsive to the missing packet and the round-up time update request and being unresponsive to receipt of any other packets from the transmitter.

a9 B2

a10 C2

19. (Amended) A congestion control method according to claim 15, wherein the step of increasing the congestion window includes the step of multiplicatively increasing the congestion window if no negative acknowledgement for the missing packet is received before expiry of the round-trip timer.

B3

20. (Amended) A congestion control method according to claim 15, further including steps of sending a keep-alive request from the transmitter to the receiver, and setting a re-transmission

Received from < +6135639869 > at 2/18/03 2:17:39 PM [Eastern Standard Time]

time-out timer to detect a re-transmission time-out, the receiver being responsive to the missing packet and the keep-alive request and being unresponsive to receipt of any other packets from the transmitter.

22. (Amended) A data communications system employing transmission control protocol for providing error recovery and congestion control on a data communications network, comprising:

a transmitter for sending a sequence of data packets, the transmitter having a round- trip timer that is set upon sending each data packet;

a receiver for receiving the sequence of data packets, a communication link between the transmitter and the receiver being established through a TCP handshake, the receiver detecting a missing packet in the sequence of data packets, and returning a negative acknowledgment for the missing data packet to the transmitter to cause re-transmission of the missing data packet, the receiver being responsive to the missing packet and being unresponsive to receipt of any other packets from the transmitter; and

means for adjusting a congestion window in response to receipt of the negative acknowledgment, and expiry of the round-trip timer.

23. (Amended) A system according to claim 22, further including a missing-packet timer at the receiver upon expiry of which a final negative acknowledgment is sent to the transmitter.

24. (Amended) A system according to claim 22, further including a re-transmission time-out timer at the transmitter, the means for adjusting responding to expiry of the re-transmission time-out timer.

25. (New) A method of transmitting data in a data communications network, comprising the steps of:

establishing a communications link between a transmitter and a receiver, the communications link having a congestion window set to an initial length;

transmitting data packets from the transmitter to the receiver;

setting a round-trip timer at the transmitter upon transmitting the data packet;

detecting a missing packet at the receiver;

sending a negative acknowledgment from the receiver to the transmitter for the missing

Received from < +6135639869 > at 2/18/03 2:17:39 PM [Eastern Standard Time]

data packet;

decreasing the length of the congestion window in response to the negative acknowledgment; and

re-transmitting the missing packet; and

increasing the congestion window upon expiry of the return trip timer, the congestion window being doubled.

a12

26. (New) A method for congestion control in a data communications network where data is transmitted as a sequence of data packets from a transmitter to a receiver, comprising the steps of:

setting a congestion window to an initial size, the congestion window relating to a transmission rate over the network;

transmitting a data packet from the transmitter to the receiver;

setting a round-trip timer at the transmitter upon sending the packet;

increasing the congestion window if no negative acknowledgment for the data packet is received before expiry of the round-trip timer; and

cont'd

decreasing the length of the congestion window if a negative acknowledgment for the data packet is received at the transmitter

wherein the congestion window is doubled, and an interval between transmission of subsequent data packets is decreased, upon expiry of the round-trip timer.

27. (New) A data communications system employing transmission control protocol for providing error recovery and congestion control on a data communications network, comprising:

a transmitter for sending a sequence of data packets, the transmitter having a round- trip timer that is set upon sending each data packet;

a receiver for receiving the sequence of data packets, the receiver detecting a missing packet in the sequence of data packets, and returning a negative acknowledgment for the missing data packet to the transmitter to cause re-transmission of the missing data packet; and

means for adjusting a congestion window in response to receipt of the negative acknowledgment, and expiry of the round-trip timer,

the transmitter including a re-transmission time-out timer, the means for adjusting

Received from <+6135639869> at 2/18/03 2:17:39 PM [Eastern Standard Time]